TIOGA CREEK

SEDIMENT BUDGET & DYNAMICS INVESTIGATION

M. J. Scalici
September 1996

reconstructed from original
computer file August 1999

Objectives

The principal objectives of this report were the following:

a) To produce a first order sediment budget of the Tioga Creek Watershed using sequential aerial photographs, past stream surveys and ten years of streamflow records.

b) To identify the principal processes of sediment production and delivery to the channels throughout the Holocene and during the last 50 years of land use management.

c) To evaluate the spatial and temporal scales of sediment production from the hillslopes and transport within the stream channels.

d) To evaluate the temporal changes to channel morphology in the last 50 years.

By addressing these issues, we may begin to address the questions: Have road building and timber harvest altered the rate of fine sediment delivery to the streams and changed the caliber and volume of woody debris in the streams beyond the range experienced during the late Holocene ?

Notes on the August 1999 reconstruction: The author of the Tioga Creek Sediment Budget & Dynamics Investigation left Coos Bay District shortly after completing this document. As far as we can tell, no hard copy of the document with a complete set of figures was ever prepared and filed. The original document resided as a computer file in the Umpqua Resource Area's Watershed Analysis directory from September 1996 to August 1999. The file was revisited during the preparation of the South Fork Coos Watershed Analysis. The computer file contained sufficient information to allow reconstruction of most of the figures. However, the available information will not allow an accurate reconstruction of figures 1and 12. This document received minor formatting, clarity and spelling edits, and a single correction: The 1959 aerial photos cited in this reconstruction were incorrectly called a 1955 flight in the original document. Otherwise the contents of the 1999 reconstruction is the same as that contained in the original 1996 computer file. **-** FNP editor

Background

Sediment Production- definitions of types: The primary source of sediment to many stream channels comes from relatively infrequent ***mass wasting events***. Mass wasting is the downslope movement of soil or rock material under the influence of gravity without the direct aid of other media such as water, air, or ice (Selby, 1982). Water and ice, however, frequently contribute to mass wasting by reducing the strength of slope materials and by increasing the plasticity and fluid behavior of soils (Selby, 1982).

There are several classification schemes that have been created to describe the types of mass wasting. Here, we will use that of Varnes (1958). He identified three types of landslides: ***debris slides, debris avalanches*** and ***debris flows*** are collectively called ***translational slides***. They are distinguished from each other by the degree of deformation of the soil material and the water content of the sliding material (Selby, 1982).

Debris slides and avalanches are typically dry while debris flows tend to be wet. These features are common shallow features on the hillslopes of the Tioga Subwatershed. Since both deformation and water content tend to increase downslope, what may be a debris slide at the crown of the slide (with relatively large, undeformed blocks of soil sliding downhill) may become an avalanche of small blocks and wet debris in the midslope and a fully liquified flow at the base of the slope. Translational slides nearly always occur during heavy rain when the intensity and duration are sufficient to raise the water table to near the soil surface or fill pre-existing tension cracks. If the capacity of soil to drain is exceeded for long enough so that water pressures rise substantially, the soil loses its strength and the probability of failures to occur is at a maximum.

Other types of movements are ***rock falls, soil falls, slumps*** and ***block glides***. Falls occur in steep terrain with weak materials and are short in extent. They may occur as their toe is undermined by river scour or wave action, by weathering and the opening of fissures near the cliff top, or by earthquakes jarring loose rocks on the headwalls. Some large, angular boulders occasionally seen in stream channels often occur as rockfalls.

Slumps have curved failure planes and involve the rotational movement of the soil mass. They too may occur as their toe is undermined. ***Soil creep*** is the slow, downslope movement of superficial soil or rock debris which is typically imperceptible in the field except when observed over long time periods.

Factors contributing to landsliding: There are numerous potential factors that contribute to a landslide. They are generally split into two primary categories- those contributing to ***high shear stress*** and those contributing to ***low shear strength*** (Selby, 1982).

THE TIOGA SUBWATERSHED

Geology and topography: The Tioga Subwatershed is a steep, rugged basin that drains some 24,678 acres of the Southern Oregon Coast Range (Figure 1). Sandstone with minor amounts of siltstone formed in the Eocene in shallow seas, known as the ***Tyee formation*** is the principal rock type found in the Subwatershed. Rapid uplift over the last few million years as a result of the development of the Cascadia Subduction zone has raised these sediments above sea level. Bedrock failures in this relatively weak rock, occurring since the Pleistocene, have produced the steep, deeply incised hillslopes throughout the coast range. While no faults have been mapped in the Tioga Subwatershed, many minor folds exist. The highest elevations in the Tioga Subwatershed are about 2,700 ft above sea level but most of the headwaters range between 1,500 and 2,000 ft.

There is a considerable body of evidence that large magnitude earthquakes have occurred on the Cascadia Subduction zone throughout the Holocene (Atwater, 1987; Clarke and Carver, 1992). The most recent ones were 300, 1,100 and 2,000 years ago. A large magnitude earthquake occurring in the winter months when the ground is saturated would likely generate numerous hillslope failures. Deeply incised tributaries with fields of very large boulder and debris fans at their bases suggest some very large magnitude failures have occurred in past centuries and it is quite likely that at least some of these events were triggered by earthquakes.

Climate: Climate in the region is strongly influenced by marine conditions in the Coast Range of Oregon. Precipitation is decidedly seasonal with some 80% of the total annual precipitation occurring as rain between November and March. Annual precipitation around the Tioga Subwatershed typically ranges between 60-80 inches (150-200 cm). Temperatures are mild year-round, and occasionally dips below freezing in the winter and rarely exceeds 100^{o}F in the summer. During the summer months, fog often extends into the Tioga Subwatershed, moderating temperatures and provides dry-season moisture. The prevailing winds are generally west to northwest. During winter storms, winds are from the south and southwest.

Vegetation: The combination of abundant rainfall and moisture, mild temperatures and relatively poor soils has produced coniferous forests often with thick understories of evergreen shrubs. Fires of various frequencies have influenced the landscape patterns. The oldest stands in the Tioga Subwatershed were dated from the 1500's with 50-100 year old understories. The most complex fire history occurred in the central part of the Subwatershed which had stand replacement fires. The northwest part of the Subwatershed had forests that began growing in the 1700's with understories dating from the mid-1800's (Tioga Appendix: Fire History).

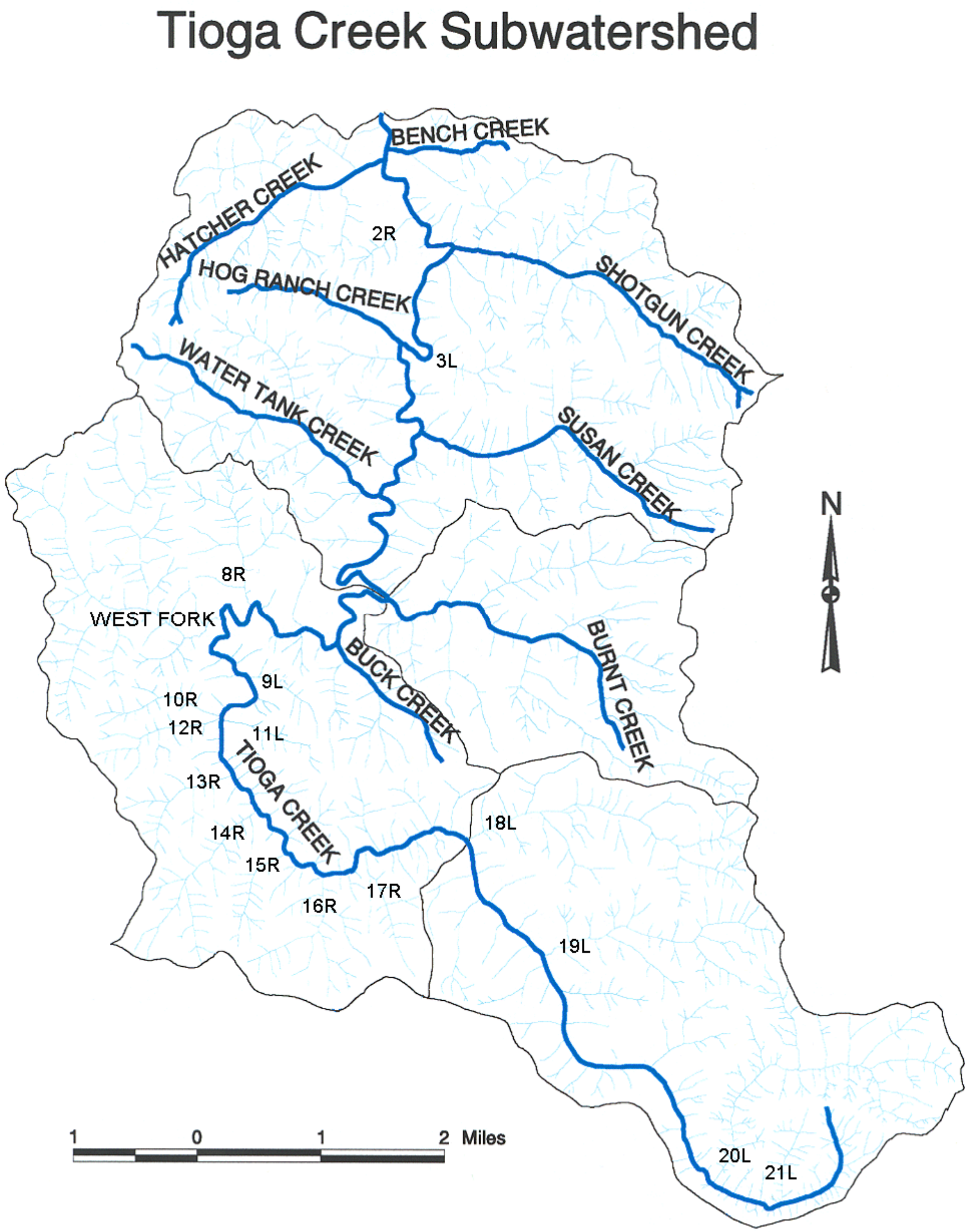

Figure 1: Tioga Creek Subwatershed **[Note: The original for figure 1 was lost, and therefore unavailable for this edition of the document. The original caption for figure 1 was: *The Tioga Watershed showing the distance of the channel measured from the mouth (miles) and tributary names.*]**

Table 1 shows the aerial photographs used in this analysis:

Date	Scale	*Flight line*- photo numbers
1943	1:40,000?	*028*-9--*028*-11; *029*-11--*029*-12; *030*-11--*030* -13
1950, May 25, July 15	1:12,000	**COQ 4** 86-89; *11*-9-- *11*-20; *9*-31--*9*-35; *4*-86--*4*-96; *10*-22--*10*-26
1955, Aug.4	1:15,840	**CH-BR** *7*-13--*7*-14; *6*-12--*6*-14; *7*-11--*7*-14; *8*-6--*8*-8; *9*-5--*9*-9; **CB-COQ** *20* -38--*20*-44; *21B*-4--*21B*-14
1963, June 17	1:12,000	**CB 3 M-COQ** *15*-21--*15*-32; *14*-20--*14*-21; *16*-22--*16*-23; *17*-18--*17*-24; *18*-19--*18*-25; *19*-15--*19*-18; *20*-15--*20*-16
1964, Aug.14	1:12,000	**CB-TIOGA4** *1*-7--*1*-12; *2*-1--*2*-11; *3*-1--*3*-11
1965, July 3	1:15,840	**CB-8-SFC-65** *4*-5--*4*-12; *5*-3--*5*-10; *6*-2--*6*-10; *7*-1--*7*-9; *8*-2--*8*-3
1976, June 17	1:12,000	**CBLC-IR** *9*-*30A*-18--*9*-*30A*-28; *9*-*32*-35--*9*-*32*-46; *9*-*33*-16--*9*-*33*-19; *9*-*31*-37--*9*-*31*-47; *8*-*29*-36--*8*-*29*-44
1986, June 11	1:12,000	**O-86-ACBC** *19*-*36A*-30--*19*-*36A*-38; *19*-*34*-41--*19*-*34*-53
1992, July 26	1:12,000	**O-92-ACBC** *12*-*39A*-53--*12*-*39A*-60; *13*-*38A*-32--*13*-*38A*-38 *15*-*42*-46--*15*-*42*-59; *15*-*43*-44--*15*-*43*-51; *16*-*40A*-49--*16*-*40A*-58; *16*-*41*-48--*16*-*41*-59; *18*-*44*-47--*18*-*44*-48; *18*-*44A*-24--*18*-*44A*-28

SUMMARY

Photo and topographic map analysis suggests that the north-flowing tributary subwatersheds were the more deeply incised than those flowing other directions, suggesting that landsliding has always been most prevalent in these areas. North-flowing subwatersheds tend to retain moisture later in the year and have the tendency to weather more readily. Transitory stresses such as earthquakes may be major factors in inducing landslides by increasing shear stress as well as decreasing the shear strength of the material.

Landsliding always has been a dominant form of sediment delivery to Tioga Creek. Debris torrents and avalanches are important processes in the Tioga watershed because they are a principal delivery mechanism of gravel and woody debris to its streams. Road construction and logging that started in the 1940's and peaked in the 1960's-70's influenced the timing of sediment delivery to Tioga Creek and the rate when measured over a period of years to a few decades. A pulse of sedimentation reached the lower Tioga Creek in the 1960's which began flushing out by the mid-1970's. Removal of numerous log jams occurred from the mid 1970's to the early ‘80's and probably mobilized the gravels stored behind them that were flushed through the Tioga system and into the South Fork Coos River. Throughout the 1980's and ‘90's, riparian vegetation matured such that Tioga Creek underwent channel incision during these decades.

While road building and timber harvest altered the rate of fine sediment delivery to the channels of the Tioga Subwatershed and changed the caliber and volume of woody debris within the channels, they did so within the range experienced during the late Holocene. These land use practices altered the rate and timing of these processes on the scale temporal scale of years to decades, but on the scale of centuries, earthquakes and fires have probably contributed far more sediment to the Tioga Creek system. Nonetheless, current and future road building and logging practices should be done such that the potential for generating landslides and soil loss is minimized.

Chronological Description of the Tioga Watershed

Below, I will give a more detailed chronological description of the Tioga watershed based on:
1) aerial photograph analysis,
2) stream surveys conducted in the 1970's,
3) stage-discharge relations at Coos County’s Tioga Creek stream flow gaging station and
4) field reconnaissance conducted in 1996.

The Holocene

Little is known about long-term sediment yield and fluvial transport rates. There are however, some large scale landscape features identified on aerial photographs and field reconnaissance missions that give clues to these processes.

The 1943 photo set was taken at the onset of entry into the Tioga Creek Subwatershed and, for all practical purposes, represents pre-timber harvest conditions. Based on those photographs, about 78% of the Subwatershed supported late-seral stage forest in the early part of the century.

Many deeply incised first order tributaries and an intricate mosaic of forest successional patterns were evident in this photo set. The most deeply incised areas were in the north and north-northwest-flowing tributaries of Shotgun Creek; tributaries to the small drainage in the South ½ Sec.20, T 26 S, R 9 W; the NNW-flowing draws draining the steep slopes in the south ½ Sec.7, T 27 S, R 9 W; and the NNW-flowing headwater tributaries of Buck Creek (SE quad Sec.6 and NE quad Sec.7, T 27 S, R 9 W) (See Figure 2).

Early successional vegetation in valley bottoms, indicative of recent debris torrents, were evident in the NNW-flowing Tioga tributary **17R** (East ½ Sec.18, T 27 S, R 9 W); around the **confluence of Upper Tioga Creek and Wilson’s Folly Creek** (Sec.8, T 27 S, R 9 W); and the WNW-flowing Tioga tributary **11L** (SE 1/4 Sec.1, T 27 S, R 10 W). The NE-flowing Tioga tributary **14R** (Sec.12, T 27 S, R 10 W) apparently possessed mature timber in its valley bottom and showed no evidence of past debris flows or torrents, a situation that would change in the following decade.

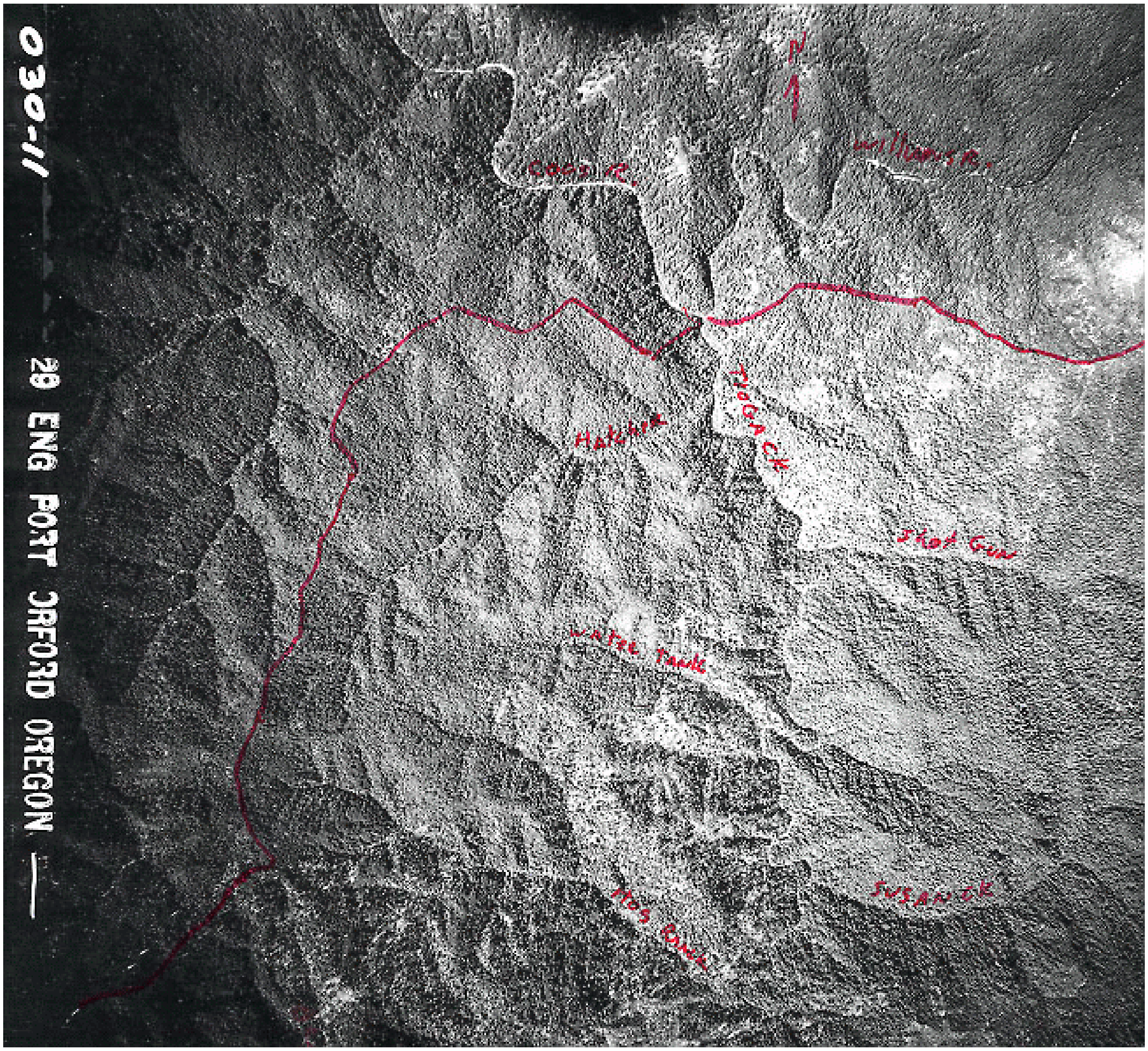

Figure 2: 1943 aerial photograph showing lower Tioga Creek.

1950
This photo set was taken at a time when intensive logging was on the increase. A road had already been punched up the lower few miles of the Subwatershed from the mouth in 1943 and fresh scarps were clearly visible at the base of the valley wall as a result of the road cut (Figure 3). The **Tioga Splash Dam** was in use, impounding water up to the first major meander about half mile upstream of the mouth *(COQ 4*-87*,* 4-86). Numerous logs were visible in this impounded reach*(COQ 16*- 8*, 16*-9). Photos *4*-90 and *4*-91 showed no logging and no fresh slides evident in the **Water Tank Creek** drainage.

A few fresh slides were observed outside of the lower subwatershed in this photo set. Small slides were apparent on tributaries of **Buck Creek** (Sec.6, T 27 S, R 9 W) that were possibly activated during the storms of the previous winter. Some skid logging was occurring on the hillslopes around **Burnt** and **Buck Creeks** (Photos *4*-90--*4*-91) and logs were being dumped into Tioga Creek so that they could be sent downstream to the mills. These practices were decreasing the stability of the channels and increasing rates of sediment delivery to the streams well above the rates prior to logging.

The aerial photographs indicate that large pulses of sedimentation were being delivered to the lower reaches of Tioga Creek from road construction and logging/ log transport practices by the mid-1940's. The upper reaches of the Subwatershed were still relatively undisturbed by such practices.

Figure 3: The 1950 photo, *COQ 16*-9 showing lower Tioga Creek and the Tioga Splash Dam. Logs were skidded down the steep hillslopes above the road and dumped into the impounded lower Tioga Creek. Opening the dam would drain the water and mobilize the logs.